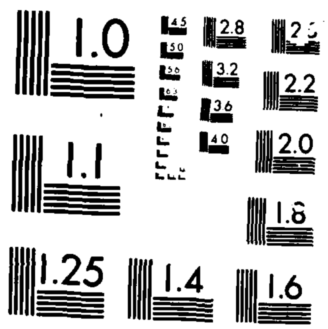
AD-A166 323 ACOUSTIC DESCRIPTION OF SOUTH ATLANTIC OCEAN WARM CORE EDDY(U) NAVAL UNDERWATER SYSTEMS CENTER NEWPORT RI L S PETITPAS ET AL. 10 MAR 86 NUSC-TD-7615 1/1

UNCLASSIFIED F/G 20/1 NL



MICROCOPY RESOLUTION TEST CHART

(2)

NUSC Technical Document 7615
10 March 1986

AD-A166 323

Acoustic Description of South Atlantic Ocean Warm Core Eddy

A Paper Presented at the 1986 Ocean Sciences Meeting of the American Geophysical Union and the American Society of Limnology and Oceanography, 13-17 January 1986, New Orleans, Louisiana

Linda S. Petitpas
David G. Browning
Surface Ship Sonar Department

Naval Underwater Systems Center
Newport, Rhode Island / New London, Connecticut

PREFACE

The work reported in this document was completed under NUSC New Employee Bid & Proposal Project No. 733P83, "Acoustic Description of Warm Core Fronts," Principal Investigator, L. Petitpas (Code 3332). The data were obtained from an ONR sponsored project onboard the R/V Washington (Chief Scientist, Dr. A. Gordon, Lamont Doherty Geological Observatory (LDGO)) in conjunction with P. Scully-Power space shuttle flight.

The authors would like to thank Dr. A. Gordon and B. Huber (LDGO) for their help in supplying the data. We would also like to thank G. Botseas (Code 3332), P. Scully-Power (Code 101), CDR J. Hughes (Code 33A2), and J. Gallagher (Code 33A1) for their comments and suggestions during the course of this work.

REVIEWED AND APPROVED: ~~10~~ March 1986

L. FREEMAN
HEAD: SURFACE SHIP SONAR DEPARTMENT

The authors of this document are located at the
Naval Underwater Systems Center, New London Laboratory,
New London, Connecticut 06320.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NUSC Techical Document 7615	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Underwater Sys. Center 6b. OFFICE SYMBOL (If applicable) 3331	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) New London, CT 06378	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Naval Underwater Sys. Center 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Newport, RI 02841	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. 733P83 / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
ACOUSTIC DESCRIPTION OF SOUTH ATLANTIC OCEAN WARM CORE EDDY

12. PERSONAL AUTHOR(S)
Linda S. Petitpas and David G. Browning

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
	FROM ______ TO ______	86 March 10	12

16. SUPPLEMENTARY NOTATION
A Paper Presented at the 1986 Ocean Sciences Meeting of the American Geophysical Union and the Americal Society of Limnology and Oceanography, 13-17 Jan. 85, New Orleans, LA

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Acoustical Propagation Brazil-Malvinas (Falkland) Confluence Range-Dependent Acoustic Model

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This document contains the viewgraph presentation entitled "Acoustic Description of South Atlantic Ocean Warm Core Eddy," given at the 1986 Ocean Sciences Meeting of the American Geophysical Union and the American Society of Limnology and Oceanography, 13-17 January 1986, in New Orleans, Louisiana.

During 30 September to 22 October 1985 an ONR sponsored project onboard the R/V WASHINGTON (Chief Scientist, Dr. Arnold Gordon, Lamont Doherty Geological Observatory) investigated the thermohaline/baroclinic scales of the meso-scale eddies associated within the Brazil-Malvinas (Falkland) Confluence.

One of the eddies investigated was a warm core anti-cyclonic eddy centered about 43°50'S and 54°15'W (18-19 October) with a diameter of 125 km. The XBT's and CTD's taken through the eddy were used with a range-dependent acoustic prediction ray model

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Linda S. Petitpas	22b. TELEPHONE (Include Area Code) (203)440-4629 / 22c. OFFICE SYMBOL 3331

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

19. (Cont'd)

(GRASS) to model a cross-section of the eddy at 50 Hz comparing propagation loss with source depths of 25, 150, and 500 m and receiver depths of 25, 150, and 500 m. Comparisons were done propagating through the eddy, from the outer edge to the eddy interior, and from the interior to the outer edge. The results were compared with a no eddy, range-independent situation.

Results showed that due to the presence of a surface duct in the warm core eddy the greatest impact was found propagating a shallow source with a shallow receiver. No effects were seen below 300 m, similar to the North Pacific and Greeland Sea eddies. (Work sponsored by NUSC.)

ACOUSTIC DESCRIPTION OF SOUTH ATLANTIC OCEAN WARM CORE EDDY

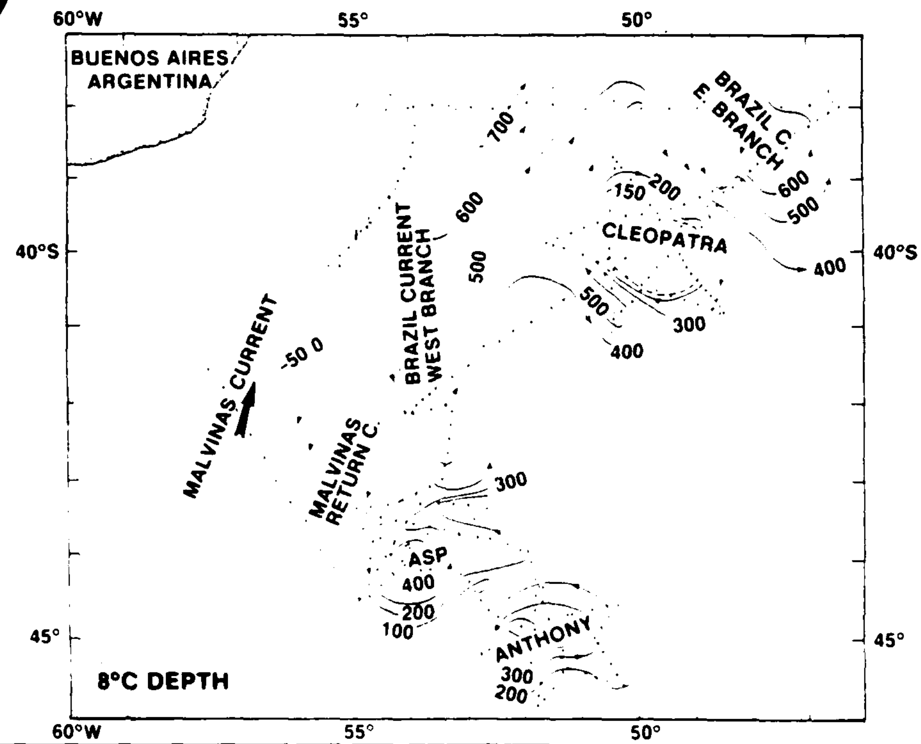
L.S. PETITPAS, D.G. BROWNING
NAVAL UNDERWATER SYSTEMS CENTER
NEW LONDON, CT 06320

L51241aP

VIEWGRAPH 1

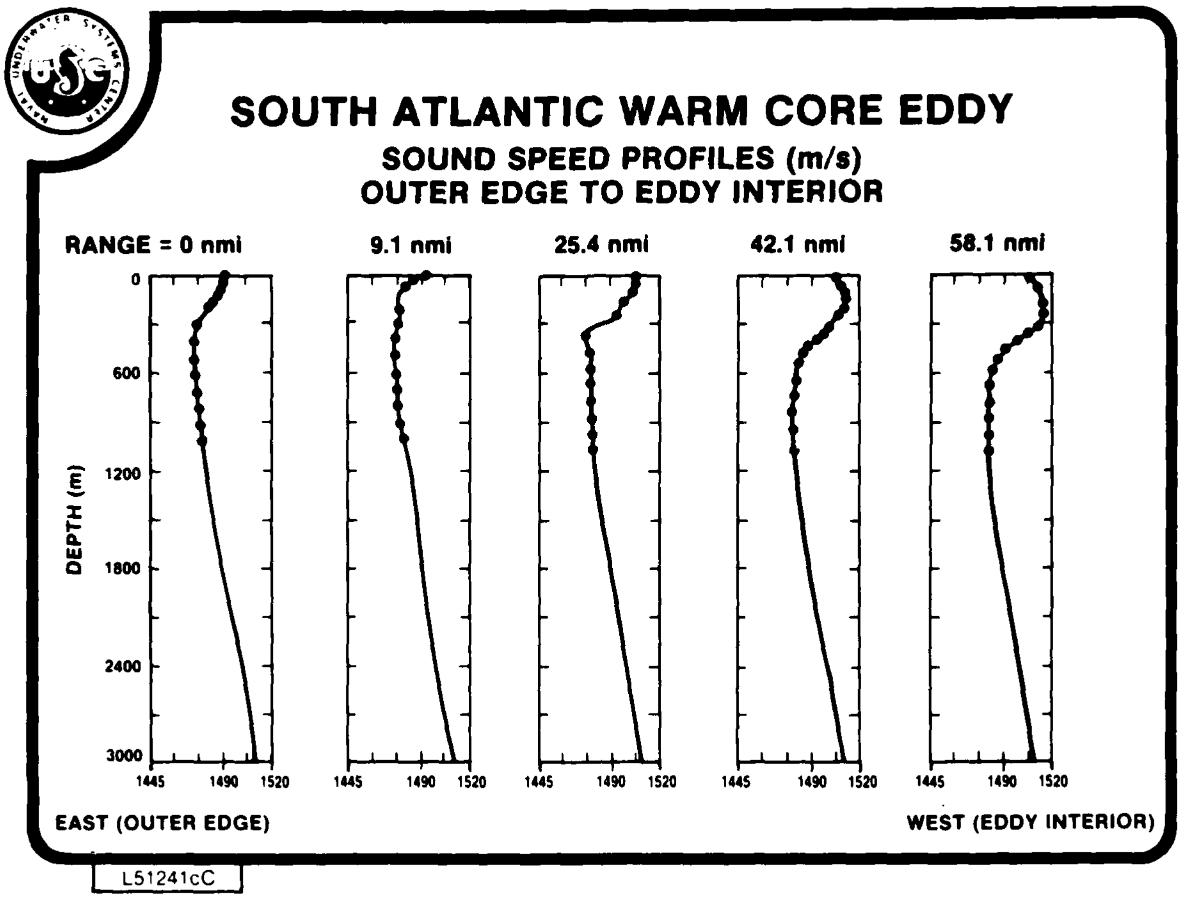
Acoustically speaking, all warm core ocean eddies are not alike. In fact the warm core eddies from each of the several locations studied to date, such as the East Australian Current and the Subarctic North-East Pacific, have been distinctly different. Thanks to the generosity of Dr. A. Gordon and the Lamont Group who provided us with the oceanographic data, this paper will present a brief analysis of the acoustic characteristics of a warm core eddy from another significant oceanographic region, the confluence of the Brazilian and Malvinas Currents in the South Atlantic Ocean.

SOUTH ATLANTIC OCEAN EDDIES OFF THE COAST OF ARGENTINA



VIEWGRAPH 2

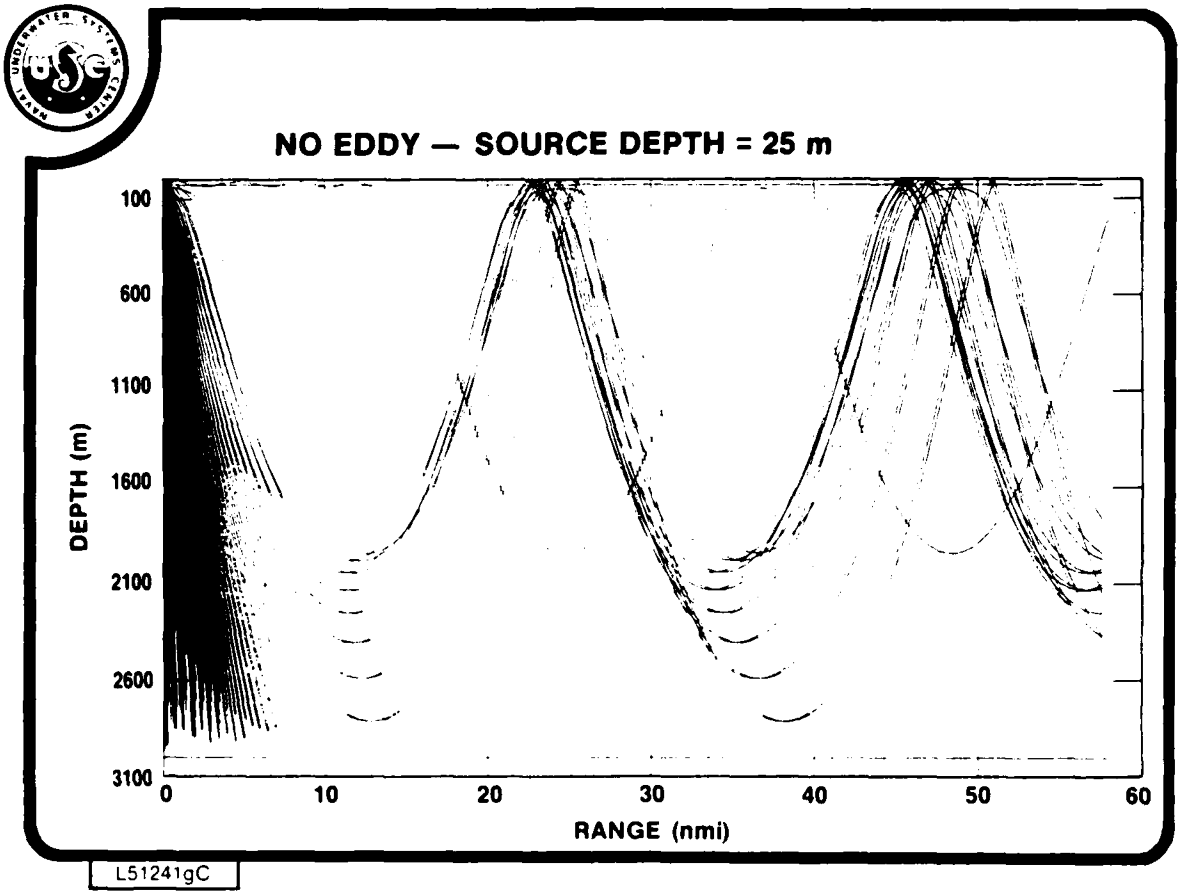
Details of these eddies produced near the confluence of the cold northward flowing Malvinas Current and the warm southward flowing Brazilian Current have been presented earlier by the Lamont Group. We have chosen to acoustically model a section of the warm core eddy designated as ASP, tragically placed between Anthony (below) and Cleopatra (above).



VIEWGRAPH 3

The sound speed profiles we have used form a section from the edge of the eddy (on your left) to its center (on your right). The edge profile, which is also the normal profile if the eddy isn't present, has a very weak surface duct. This profile, due to a cool surface temperature, is surface- limited with a deep sound channel axis of about 300 meters.

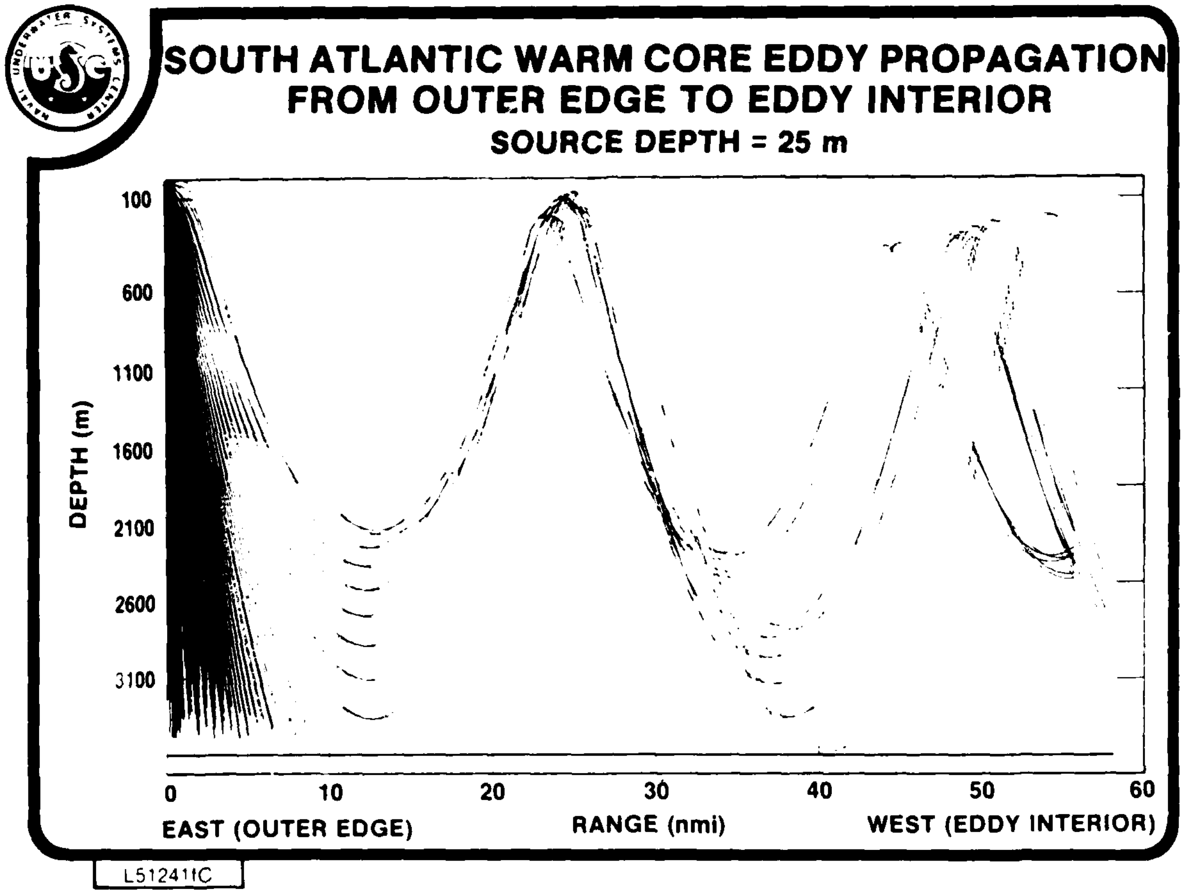
As we progress into the warm core, the surface sound speed increases, first quenching the weak surface duct and then forming a stronger one. The profile becomes bottom- limited and the deep sound channel axis deepens to approximately 600 meters.



VIEWGRAPH 4

The first ray diagram is the edge or normal profile with a source depth of 25 meters. All our results are obtained with the GRASS range-dependent acoustic prediction model at 50 Hz.

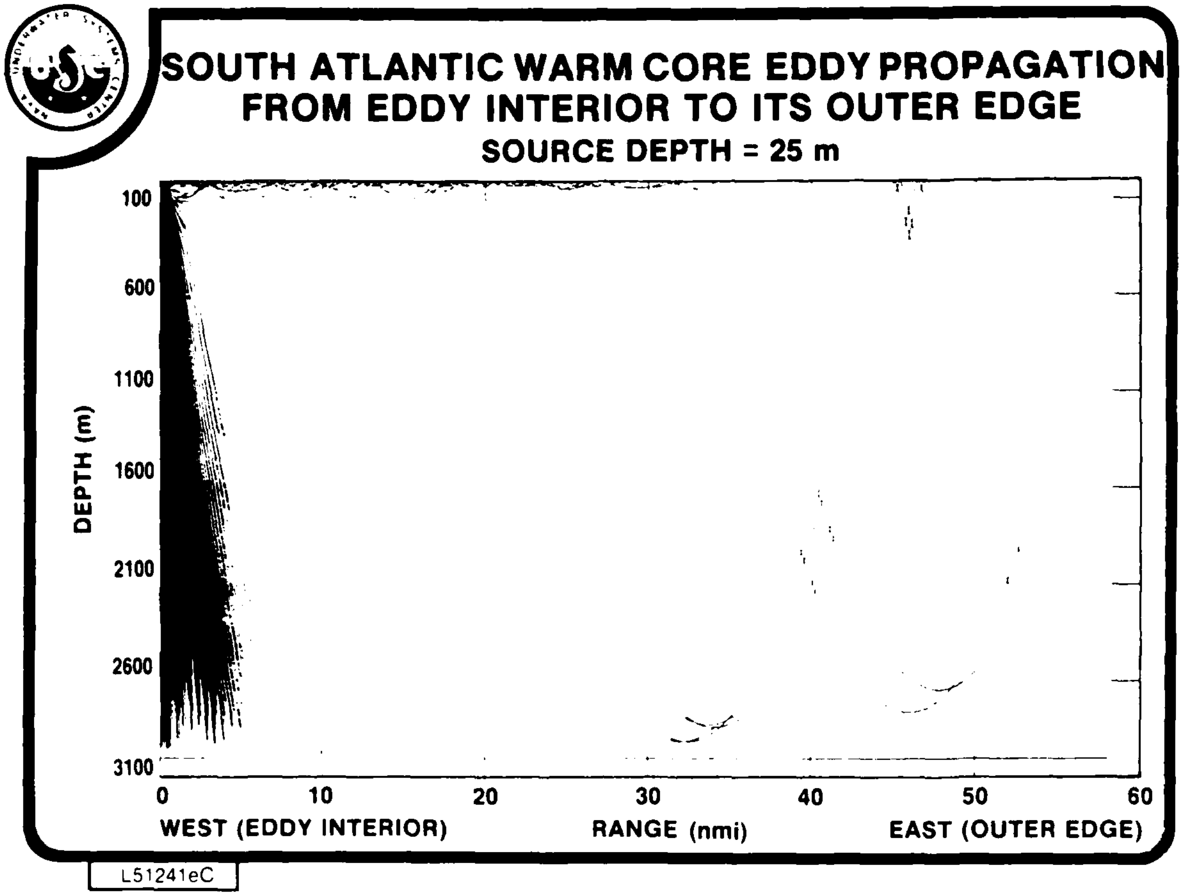
You can see the extremely weak surface duct, the convergence zone (CZ) that vertexes at or near the surface, and the steeper angle rays that are terminated when they strike the bottom.



VIEWGRAPH 5

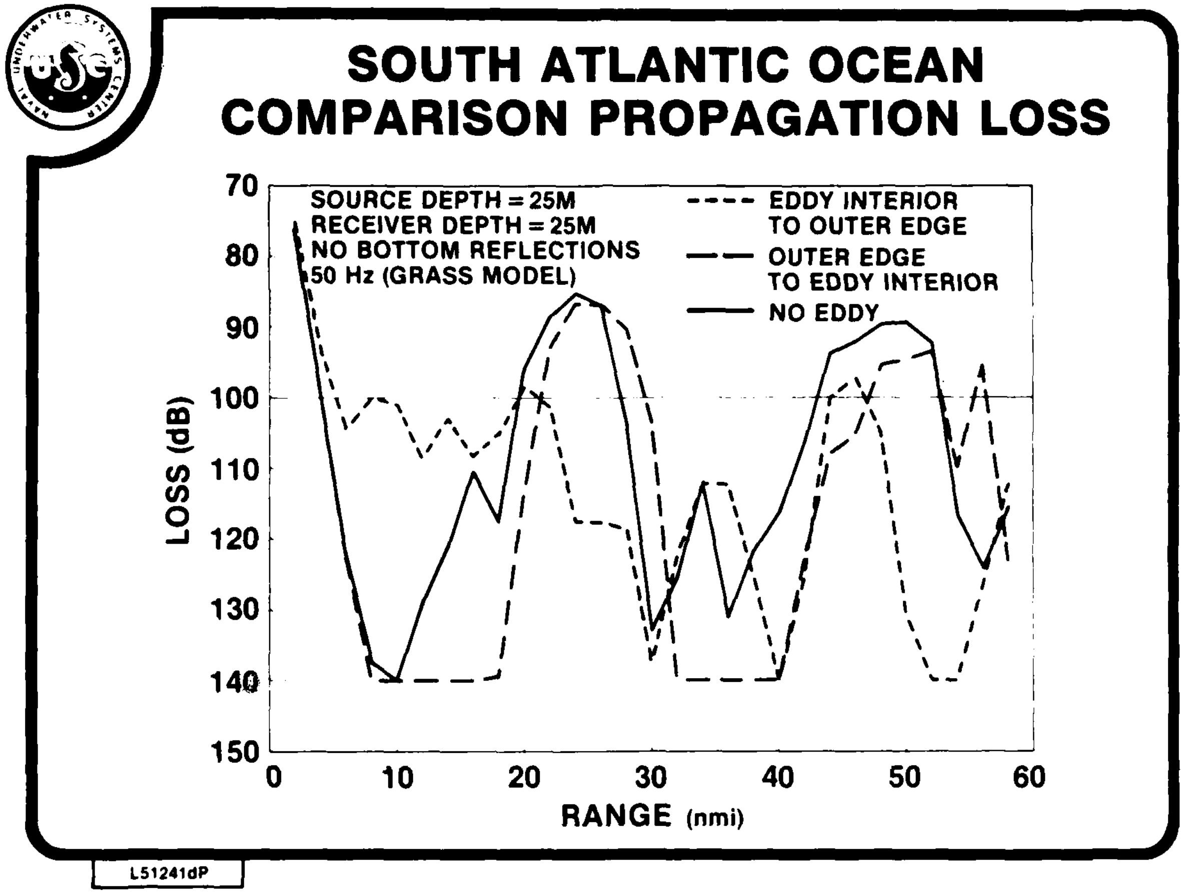
Again starting with the edge profile, we now run the range-dependent section into the core of the eddy with the source at 25 meters.

Although the weak surface duct is quenched, the general pattern, which is dominated by CZ paths, is similar to the normal case. Note, however, how the vertexing rays of the CZ become deeper as we progress into the warm core with its higher surface sound speeds.



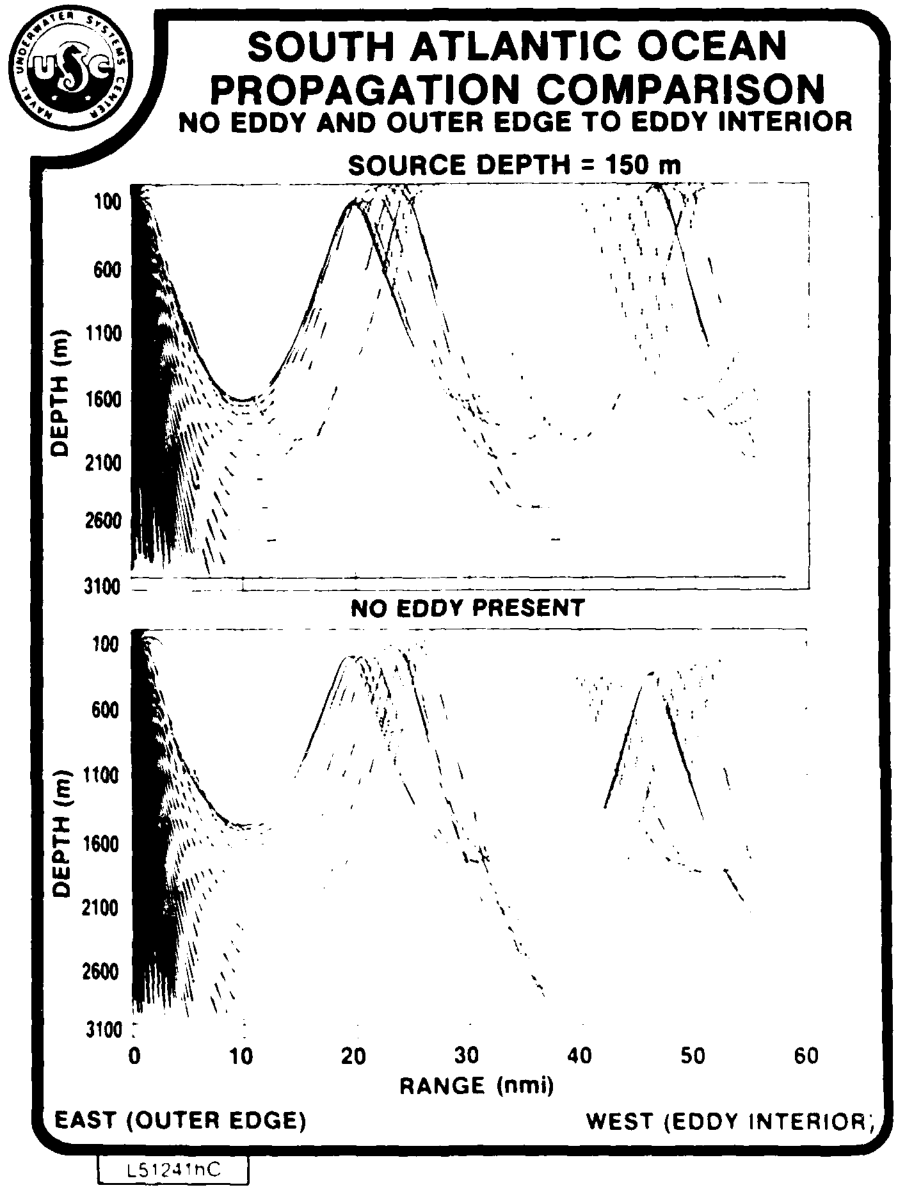
VIEWGRAPH 6

If we run the same section outward from the center to the edge, the results are strikingly different. The warm core produces a strong surface duct that gradually tapers down as we move outward. Again, with the higher sound speed at the surface all potential CZ rays for our source depth of 25 meters become bottom limited and are lost.



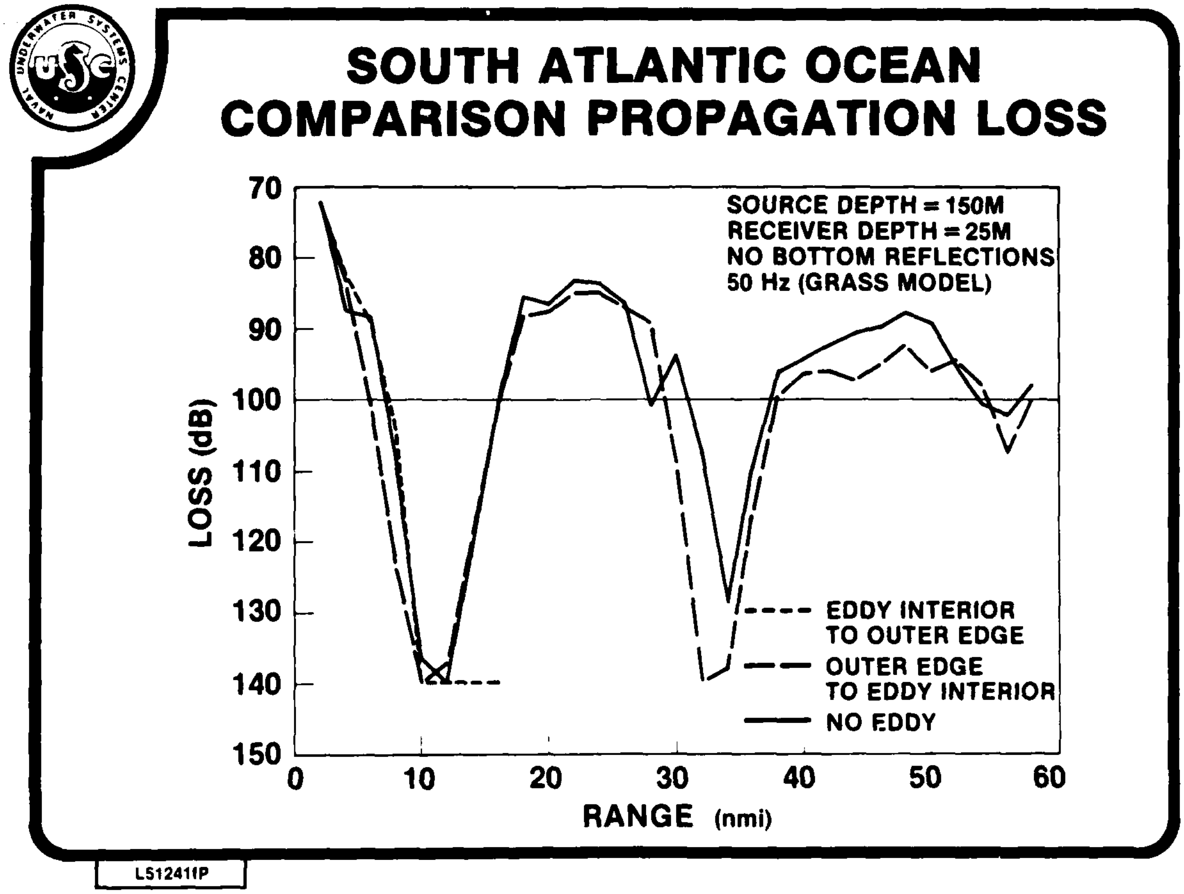
VIEWGRAPH 7

A comparison of propagation loss predictions at 50 Hz for a source depth and receiver depth of 25 meters follows the ray diagrams. Both the no eddy case (solid line) and the inward track (large dashes) are principally CZ propagation with an initial shadow zone. The outward track from the core (short dashes) is greatly different because it is initially dominated by surface duct propagation, which eventually deteriorates into some CZ propagation.



VIEWGRAPH 8

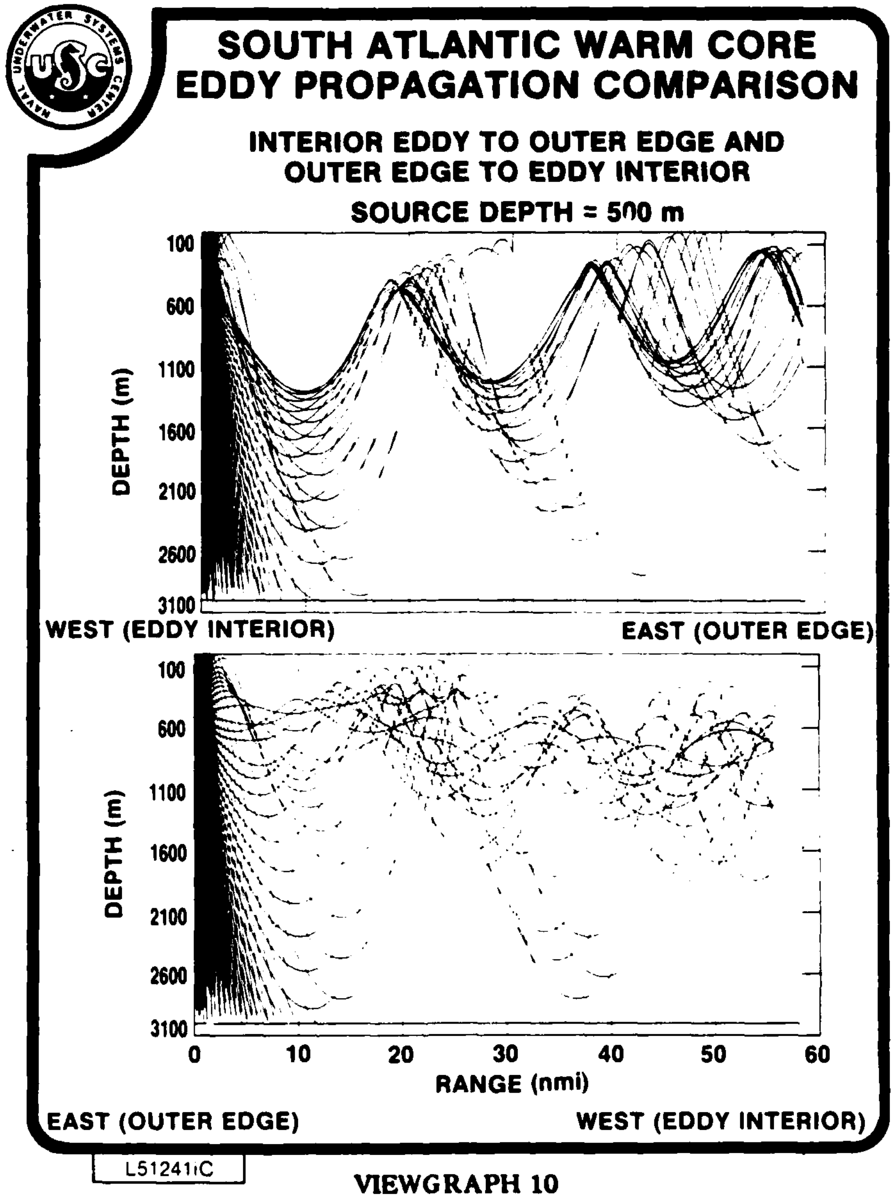
If we now lower the source depth to 150 meters we are below any surface duct and it will not be a factor. The same similarity between the no eddy case (top) and the inward track (bottom) exists. Note again the deepening of the vertexing rays as we progress into the warm core along the inward track.



VIEWGRAPH 9

With the source at 150 meters and the receiver at 25 meters, again the propagation loss for the no eddy case (solid line) and the inward track (large dashes) are initially very similar. They diverge as the changes in vertexing depth between the two become significant.

For the outward track (short dashes) look what happens! We are below the surface duct that was our principal mode for a 25- meter source, yet the sound speed is still great enough to bottom- limit any CZ rays. This is a good example of how the effect of an eddy depends on the source and receiver configuration.

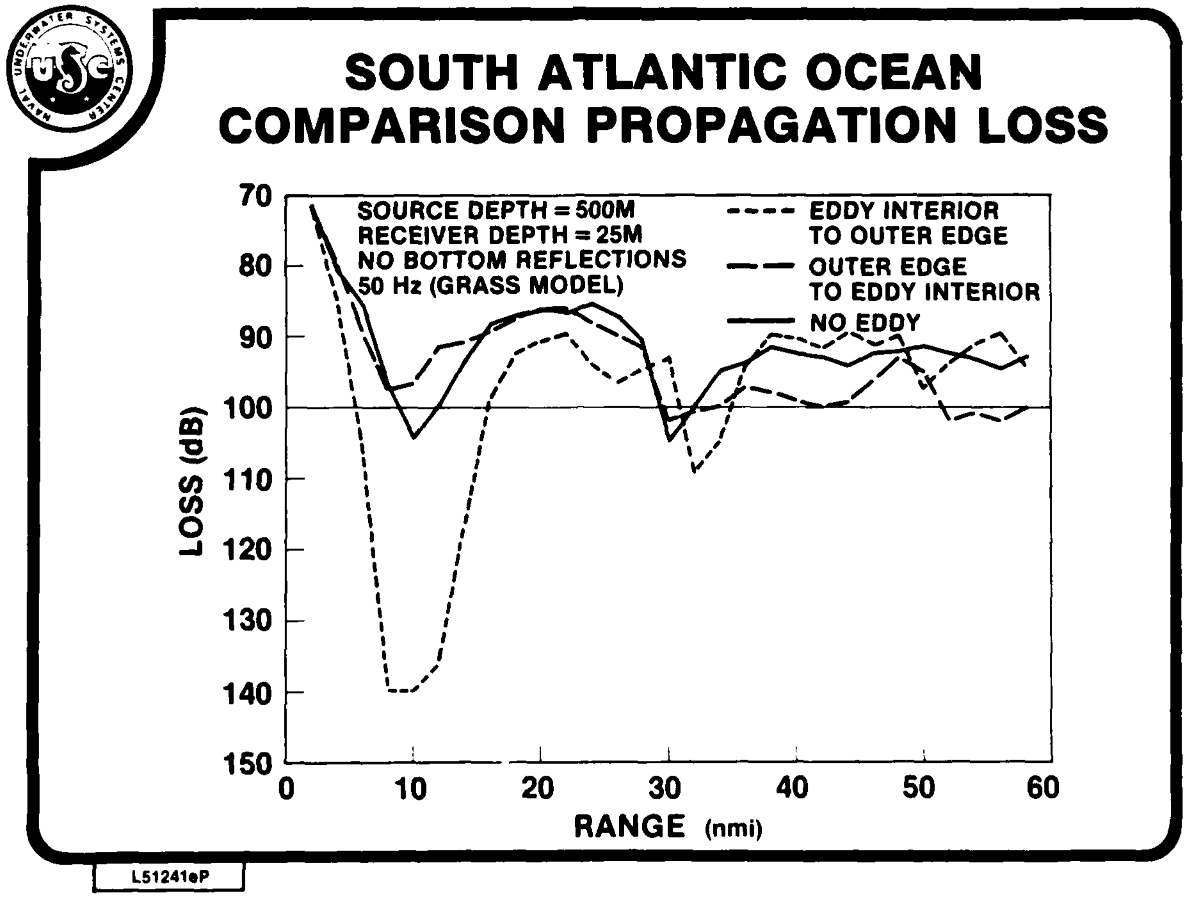


VIEWGRAPH 10

If we lower the source depth to 500 meters we are getting lower angle (near axial) rays in the deep sound channel. At this depth there is an important change for the outward track (top figure). The sound speed is now low enough to allow some CZ paths. For a 500- meter source, the initial principal model along the outward track is CZ while for a 25- meter source it was surface duct.

For the inward track (bottom figure) the increased near axial rays initially fill in the shadow zone that was present for a 25- meter source.

Note again the divergence of the inward and outward ray paths as the depths of the vertexing rays change.



VIEWGRAPH 11

The propagation loss is shown for a 500-meter source depth and a 25-meter receiver depth. The no eddy (solid line) and the inward track (large dashes) are again similar but their relationship to the outward track (small dashes) has flip-flopped compared with the 25-meter source depth case. It is the outward track that now has the initial shadow zone.

CONCLUSIONS

- SHALLOW, INTENSE WARM CORE EDDIES ARE PRODUCED NEAR THE CONFLUENCE OF THE BRAZILIAN AND MALVINAS CURRENTS
- THE WARM CORE PRODUCES AN ENHANCED SURFACE DUCT WHICH FAVORS OUTWARD TRANSMISSION BETWEEN SHALLOW SOURCE AND RECEIVER
- SIGNIFICANTLY INCREASED SURFACE SOUND SPEED IN THE WARM CORE REDUCES OUTWARD CONVERGENCE ZONE (CZ) PATHS, DEEPENS INWARD CZ VERTEXING

L60007a

VIEWGRAPH 12

We can summarize our results as follows:

1. Shallow, intense warm core eddies are produced near the confluence of the Brazilian and Malvinas Currents.

2. The warm core produces an enhanced surface duct which favors outward transmission between shallow source and receiver.

3. Significantly increased surface sound speed in the warm core reduces outward CZ zone paths and deepens inward CZ vertexing.

INITIAL DISTRIBUTION LIST

Addressee	No. of Copies
ASN (RE&S)	1
OUSDR&E (Research & Advanced Technology)	1
Deputy USDR&E (Res. & Adv. Technology)	1
Deputy USDR&E (Dir. Elect. & Phys. Sc.)	1
Principal Dept. Assist. Secretary (Research)	1
ONR (OCNR Code 30, ONR-100, -102, -220, -400, -422, -425AC)	7
CNO (OP-952)	1
DIA (DT-2C)	1
NRL (B. Adams)	1
NORDA	1
USOC (Code 240)	1
OCEANAV	1
NAVOCEANO	1
NAVELECSYSCOM (ELEX 320)	1
NAVSEASYSCOM (SEA-06, -06R, --630, -63R)	4
NAVAIRDEVCEN	1
NOSC (Code 8302)	1
NISC	1
NAVPGSCOL (Dr. H. Medwin, Dr. O. Wilson, Prof. C. Dunlap, Library)	4
NAVWARCOL	1
NETC	1
NAVEDTRSUPCENPAC	1
ARL/UW, Seattle (DR. M. Schulkin)	1
ARL/PENN STATE (Dr. S. McDaniel)	1
CNA (Acquisition Unit)	1
DTIC	12
DARPA (A. Ellinthrop)	1
MPL, SCRIPPS (Dr. F. Fisher)	1
Yale University (P. H. Schulthesis)	1
BBN, Alexandria (Dr. H. Cox)	1
BBN, New London (Dr. P. Cable)	1
ANALTECHNS (S. Elam)	1
OPERRES INC. (Dr. V. P. Simmons)	1
PSI, Marine Sciences (Dr. J. Fitzgerald, Dr. R. Mellen)	2
ONT (Dr. Theo Kooij)	1
Science Applications, Inc. (Dr. J. Brackett Hersey)	1
COMNAVSURFLANT	1
COMSUBLANT	1

END
FILMED

5-86

DTIC